ATENT COOPERATION TR TY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

United States Patent and Trademark Office
(Box PCT)
Crystal Plaza 2
Washington, DC 20231
ÉTATS-UNIS D'AMÉRIQUE

in its capacity as elected Office

Date of mailing: 29 July 1999 (29.07.99)	
International application No.: PCT/EP99/00108	Applicant's or agent's file reference: ZEM/98/274
International filing date: 11 January 1999 (11.01.99)	Priority date: 20 January 1998 (20.01.98)
Applicant: CARLI, Fabrizio et al	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International preliminary Examining Authority on:

25 June 1999 (25.06.99)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer:

J. Zahra

Telephone No.: (41-22) 338.83.38

PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

GIUGNI, Valter
Propria S.r.l.
Via Mazzini, 13
I-33170 Pordenone
ITALIE

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL PRELIMINARY EXAMINATION REPORT
(PCT Rule 71.1)

Date of mailing *(day/month/year)*	03. 12. 99
Applicant's or agent's file reference ZEM/98/274	**IMPORTANT NOTIFICATION**

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/EP99/00108	11/01/1999	20/01/1998

Applicant
ZANUSSI ELETTROMECCANICA S.P.A. et al.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.

2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.

3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/	Authorized officer
European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Garvey, R Tel.+49 89 2399-2271

PATENT COOPERATION TREATY

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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
ZEM/98/274		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/EP99/00108	11/01/1999	20/01/1998
International Patent Classification (IPC) or national classification and IPC H02K1/27		
Applicant ZANUSSI ELETTROMECCANICA S.P.A. et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 6 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☒ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
25/06/1999	03. 12. 99
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Kugler, D Telephone No. +49 89 2399 2866

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/EP99/00108

I. Basis of the report

1. This report has been drawn on the basis of (*substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.*):

Description, pages:

1,3-10	as originally filed			
2,2a	as received on	23/10/1999	with letter of	18/10/1999

Claims, No.:

1-11	as received on	23/10/1999	with letter of	18/10/1999

Drawings, sheets:

1/5-5/5	as originally filed

2. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:
- ☐ the drawings, sheets:

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

4. Additional observations, if necessary:

see separate sheet

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	8,9,11
	No:	Claims	1-7,10
Inventive step (IS)	Yes:	Claims	8,9,11
	No:	Claims	1-7,10
Industrial applicability (IA)	Yes:	Claims	1-11
	No:	Claims	

2. Citations and explanations

see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

Item I

Basis of the report

The page 2a referred to in the application documents is the page having the following text in the first line: "Appendix - to be attached at point ● of description"

Re Item V

Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Reference is made to the following document cited in the international search report:

D1: EP-A-0 459 355 (HITACHI LTD) 4 December 1991

1. Document D1 describes a rotor for an electronically commutated motor (see figure 8, column 1, lines 26 to 29) that comprises:
   - a core formed by a cylindric stack 4 of magnetic laminations,
   - a plurality of segments 3 of a cylinder made of preferably sintered magnetizable materials, provided on their contiguous longitudinal edges with bevels that are preferably facing the axis of the rotor,
   - a substantially cylindrical wrapper 2, made of non magnetic material, surrounding said segments of a cylinder when these are positioned on the outer surface of the core 4,
   - at least a pair of plane elements 5, 6 (see end-plates in figure 7) joined to the end portions of said wrapper at the extremities of the core.
   - first elastic means 17 having a length that is not smaller than the length of the core (see figure 10A) and are supported by means 13 (see figure 8, column 5, line 57 to column 6, line 4) that are integrally provided in the core parallel to the axis of rotation of the rotor, which interfere with contiguous longitudinal edges of said segments of a cylinder 3 so as to keep said segments circumferentially spaced from each other (see column 3, lines 5 to 20).

The cylindrical wrapper 2 known from document D1 has also an inside diameter that is not smaller than the outside diameter of the rotor sub-assembly formed by the core 4 and the segments 3 of the cylinder. According to document D1 there is

no interference fit of the sleeve onto the subassembly composed rotor core and the magnet segments because grooves 11 are provided which are filled with a die-casting material, so that the permanent magnet segments are held and depressed against the inner circumferential surface of the sleeve. Therefore the inside diameter of the sleeve is not smaller than the outside diameter of the rotor sub-assembly formed by the core 4 and the segments 3 of the cylinder.

All the features of claim 1 are known from document D1. The subject-matter of this claim is therefore **not** new. The requirements of Article 33(2) PCT are **not** fulfilled.

2. Dependent claims 2 - 7 and 10 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of novelty and/or inventive step, the reasons being as follows:
   claim 2: see D1, figure 8, column 5, lines 42 to 47,
   claim 3: see D1, figure 12,
   claim 4: see D1, figure 10C,
   claim 5: see D1, figure 14, column 7, lines 27 to 33,
   claim 6: see D1, figure 8,
   claim 7: see D1, element 17 in figure 9,
   claim 10: see D1, column 4, lines 36 to 38.

3. The features of dependent claims 8 and 9 are not discloses nor suggested in the available prior art. For these claims the requirements of Articles 33(2) and 33(3) PCT are satisfied.

4. The process steps referred to in process claim 11 are not discloses nor suggested in the available prior art. The requirements of Articles 33(2) and 33(3) PCT are satisfied.

Re Item VII

Certain defects in the international application

5. The description is not in conformity with the claims as required by Rule 5.1(a)(iii) PCT.

The above cited retaining wrapper has an inside diameter that is smaller than the outside diameter of the rotor sub-assembly formed by the core and the magnetizable segments, as well as larger than the outside diameter of said terminal closing rings.

see APPENDIX

The drawbacks connected with these prior-art solutions derive mainly from the large dimensional tolerances of the magnetizable segments, so that the pressure exerted by the retaining wrapper is subject to considerable variations and the adhesive, which among other things needs quite a long time for hardening, must be applied in a particularly careful manner in order to ensure that it duly fills up the gaps or small sockets that are specially provided to that purpose. Furthermore, the ultimate shape of the rotor, as defined by the outer surface of the retaining wrapper, owing to the fact that the latter must at least partially follow the actual shape of the magnetizable segments, only seldom turns out to comply with the theoretical, ie. cylindrical one in practice, which introduces a few balancing problems.

All these drawbacks may quite easily pile up to constitute a considerable problem when the rotors have to be produced to as high output volumes as several thousands pieces per day, such as for instance in the case of motors used to drive the hermetic compressors of household refrigeration appliances. As a matter of fact, under these conditions it proves quite a difficult task to combine high quality and reduced production costs.

In view of doing away with some of these drawbacks, innovative design solutions have been developed by this same Applicant concerning the rotor of an electronically commutated brushless-type motor and disclosed in the Italian utility model applications nos. PN98U000003 filed on January 20, 1998 and PN98U000016 filed on March 10, 1998, whose contents are fully incorporated here.

It is a purpose of the present invention to provide a rotor of an electronically commutated motor, which may even be of a type differing from the brushless one,

ENCLOSURE NR. 2

Appendix - to be attached at point [redacted] of description

From EP-A-0 459 355 a rotor for an electronically commutated motor is also known where circumferential direction pressing members are interposed between a plurality of segment-shaped permanent magnets having the different poles and a die-casting material is filled into gaps where the the said pressing members are accomodated. No teaching is made in this reference concerning the insertion of a non-magnetic sleeve around the outer peripheries of the permanent magnets.

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ENCLOSURE NR. 1

H 23-10-98

ZEM/98/274

CLAIMS

1. Rotor for an electronically commutated motor, in particular for driving a refrigerant hermetic compressor, that comprises :

- a core (1; 30) formed by a cylindrical stack of magnetic laminations,
- a plurality of segments of a cylinder (5, 6, 7; 31, 32, 33) made of preferably sintered magnetizable materials, provided on their contiguous longitudinal edges with bevels that are preferably facing the axis (X) of the rotor
- a substantially cylindrical wrapper (10; 36), made of a non-magnetic material, preferably an austenitic steel., surrounding said segments of a cylinder (5, 6, 7; 31, 32, 33) when these are positioned on the outer surface of the core (1; 30),
- at least a pair of plane elements (8, 9; 34, 35) joined to the end portions of said wrapper (10; 36) at the extremities of the core (1; 30),
- first elastic means (11, 12, 13; 52, 53, 54) having a length (L) that is not smaller than the length (H) of the core (1; 30), and are supported by means (2, 3, 4; 49, 50, 51) that are integrally provided in the core (1; 30) parallel to the axis of rotation (X) of the rotor, which interfere with contiguous longitudinal edges of said segments of a cylinder (5, 6, 7; 31, 32, 33) so as to keep said segments circumferentially spaced from each other,

characterized in that the said cylindrical wrapper (10; 36) has an inside diameter that is not smaller than the outside diameter of the rotor sub-assembly formed by the core (1; 30) and the segments of a cylinder (5, 6, 7; 31, 32, 33).

2. Rotor according to claim 1, characterized in that it also comprises second elastic means (21-26; 37-42; 60), supported by means (14-19; 43-48) that are

integrally provided in the core (1; 30), which are adapted to ensure that the outer surface of the segments of a cylinder (5, 5, 7; 31, 32, 33) keeps in contact with the inner surface of the wrapper (10; 36).

3. Rotor according to claim 1 or 2, characterized in that (2, 3, 4) that the core (1) is integrally provided at its outer surface with peripherally arranged ribs that are regularly spaced from each other as means for supporting said first elastic means (11, 12, 13).

4. Rotor according to claim 3, characterized in that said first elastic means (11, 12, 13), and their associated supporting ribs (2, 3, 4) as well, have a cross-section in the shape of substantially a "V".

5. Rotor according to claim 1 or 2, characterized in that the core (1) is integrally provided at its outer surface with peripherally arranged slots (49, 50, 51) that are provided, regularly spaced from each other, with a cross-section in the shape of a "Ω" in order to accommodate and support the first elastic means (52, 53, 54) which are also in the shape of a "Ω" with their end portions bent to the shape of a "V" interfering with the contiguous longitudinal edges of the segments of a cylinder (31, 32, 33).

6. Rotor according to any claim 2 to 5, characterized in that the supporting means (14-19; 43-48) for said second elastic means (21-26; 37-42; 60) are grooves extending parallel to the axis of rotation (X) of the rotor and provided in a number that is equal to or a multiple of the number of the supporting means (2, 3, 4; 49, 50, 51) for said first elastic means (11, 12, 13; 52, 53, 54).

7. Rotor according to any claim 2 to 6, characterized in that said second elastic means (21-26; 37, 42) are elementary undulated springs which are supported by the core (1, 30) without using any adhesive or similar material .

8. Rotor according to any claim 2 to 6, characterized in that said second elastic means (60) comprise a cylindrical cage made of metal wire and consisting of first

parallel, preferably undulated portions (61-66) provided in a number equal to the supporting means (14-19; 43-48) thereof, second portions (67-72) formed in the shape of arcs of a circle, and preferably undulated, which are subdivided into two groups of equal number between the ends of said first portions (61-66), and radial joining portions (73-84) that are provided between the ends of each one of said first portions (61-66) and the adjacent second portions (67-72).

9. Rotor according to claim 8, characterized in that the radial extension of said joining portions (73-84) is smaller than the thickness of the segments of a cylinder (5, 6, 7; 31, 32, 33) as measured on a plane that is orthogonal to the axis of rotation (X) of the rotor.

10. Rotor according to any of the preceding claims where the said plane elements (8, 9; 34, 35) are in the form of rings made of a non-magnetic material, preferably aluminium, characterized in that the end portions of the wrapper (10; 36) are joined to said plane elements (8, 9; 34, 35) by means of a simple mechanical deformation, without any use of foreign bonding and/or sealing materials.

11. Method for producing a rotor according to any of the preceding claims, comprising substantially the phases of:

- making the core (1; 30) by stacking a plurality of magnetic laminations;

-associating said second elastic means (21-26; 37-42; 60) to respective supporting means (14-19; 43-48) integrally provided on the core;

- obtaining a rotor sub-assembly formed by the core (1;30), said second elastic means (21-26; 37, 42; 60), and the segments of a cylinder (5, 6, 7; 31, 32, 33) arranged along the outer surface of the core (1; 30);

- inserting the cylindrical wrapper (10; 36) along the axis of rotation (X) around said rotor sub-assembly with a radial play with respect thereto;

- inserting said first elastic means (11, 12, 13; 52, 53, 54) in the respective supporting means provided integrally on the core (1; 30) so as to obtain a circumferential spacing of the segments of a cylinder (5, 6, 7; 31, 32, 33) from each

other due to the same first elastic means (11, 12, 13; 52, 53, 54) interfering with the contiguous longitudinal edges of the segments of a cylinder (5, 6, 7; 31, 32, 33);

- inserting said plane elements (8, 9; 34, 35) so as to enable them to come into contact with the end portions of the core (1, 30);

- submitting the end portions of the wrapper (10; 36) and/or the plane elements (8, 9; 34, 35) to a circumferential mechanical deformation so as to enable them to mutually join to form a cylindrical, substantially sealed shell;

- magnetizing the rotor so as to enable the contiguous longitudinal edges of the segments of a cylinder (5, 6, 7; 31, 32, 33) to become opposite magnetic poles.

The above cited retaining wrapper has an inside diameter that is smaller than the outside diameter of the rotor sub-assembly formed by the core and the magnetizable segments, as well as larger than the outside diameter of said terminal closing rings.

The drawbacks connected with these prior-art solutions derive mainly from the large dimensional tolerances of the magnetizable segments, so that the pressure exerted by the retaining wrapper is subject to considerable variations and the adhesive, which among other things needs quite a long time for hardening, must be applied in a particularly careful manner in order to ensure that it duly fills up the gaps or small sockets that are specially provided to that purpose. Furthermore, the ultimate shape of the rotor, as defined by the outer surface of the retaining wrapper, owing to the fact that the latter must at least partially follow the actual shape of the magnetizable segments. only seldom turns out to comply with the theoretical, ie. cylindrical one in practice, which introduces a few balancing problems.

All these drawbacks may quite easily pile up to constitute a considerable problem when the rotors have to be produced to as high output volumes as several thousands pieces per day, such as for instance in the case of motors used to drive the hermetic compressors of household refrigeration appliances. As a matter of fact, under these conditions it proves quite a difficult task to combine high quality and reduced production costs.

In view of doing away with some of these drawbacks, innovative design solutions have been developed by this same Applicant concerning the rotor of an electronically commutated brushless-type motor and disclosed in the Italian utility model applications nos. PN98U000003 filed on January 20, 1998 and PN98U000016 filed on March 10, 1998, whose contents are fully incorporated here.

It is a purpose of the present invention to provide a rotor of an electronically commutated motor, which may even be of a type differing from the brushless one,

CLAIMS

1. Rotor for an electronically commutated motor that comprises a core (1; 30) formed by a cylindric stack of magnetic laminations, a plurality of segments of a cylinder (5, 6, 7; 31, 32, 33) made of preferably sintered magnetizable materials, a substantially cylindrical wrapper (10; 36) surrounding said segments of a cylinder (5, 6, 7; 31, 32, 33) when these are positioned on the outer surface of the core (1; 30), at least a pair of plane elements (8, 9; 34, 35) joined to the end portions of said wrapper (10; 36) at the extremities of the core (1; 30), characterized in that it also comprises first elastic means (11, 12, 13; 52, 53, 54) having a length (L) that is not smaller than the length (H) of the core (1; 30), and are supported by means (2, 3, 4; 49, 50, 51) that are integrally provided in the core (1; 30) parallelly to the axis of rotation (X) of the rotor, which interfere with contiguous longitudinal edges of said segments of a cylinder (5, 6, 7; 31, 32, 33) so as to keep said segments circumferentially spaced from each other.

2. Rotor according to claim 1, characterized in that, on their contiguous longitudinal edges, said segments of a cylinder (5, 6, 7; 31, 32, 33) are provided with bevels that are preferably facing the axis (X) of the rotor.

3. Rotor according to claim 1 or 2, characterized in that the means for supporting said first elastic means (11, 12, 13) substantially consist of ribs (2, 3, 4) that are integrally provided, regularly spaced from each other, on the outer surface of the core (1; 30);

4. Rotor according to claim 2, characterized in that said first elastic means (11, 12, 13), and preferably their supporting ribs (2, 3, 4) as well, have a cross-section in the shape of substantially a "V".

5. Rotor according to claim 1, characterized in that the means for supporting said first elastic means (11, 12, 13) substantially consist of peripherally arranged slots (49, 50, 51) that are provided, regularly spaced from each other, on the outer surface of the core (30) and have a cross-section in the shape of a "Ω", said slots being adapted to accomodate the first elastic means (52, 53, 54) which are also in the shape of a "Ω" with their end portions bent to the shape of a "V" interfering with the contiguous longitudinal edges of the segments of a cylinder (31, 32, 33).

6. Rotor according to any of the preceding claims, characterized in that said substantially cylindrical wrapper (10; 36) has an inside diameter that is not smaller than the outside diameter of the rotor sub-assembly formed by the core (1; 30) and the segments of a cylinder (5, 6, 7; 31, 32, 33), and is made of a non-magnetic material, preferably an austenitic steel.

7. Rotor according to claim 6, characterized in that it also comprises second elastic means (21-26; 37-42; 60), supported by means (14-19; 43-48) that are integrally provided in the core (1; 30), which are adapted to make up for the longitudinal and radial plays of the various parts of the rotor so as to ensure that the outer surface of the segments of a cylinder (5, 5, 7; 31, 32, 33) keeps in contact with the inner surface of the wrapper (10; 36).

8. Rotor according to claim 7, characterized in that the supporting means (14-19; 43-48) for said second elastic means (21-26; 37-42; 60) are grooves extending parallelly to the axis of rotation (X) of the rotor and provided in a number that is equal to or a multiple of the number of the supporting means (2, 3, 4; 49, 50, 51) for said first elastic means (11, 12, 13; 52, 53, 54).

9. Rotor according to claim 7 or 8, characterized in that said second elastic means (21-26; 37, 42) are elementary undulated springs.

10. Rotor according to claim 7 or 8, characterized in that said second elastic means (60) comprise a cylindric cage made of metal wire and consisting of first parallel, preferably undulated portions (61-66) provided in a number equal to the supporting means (14-19; 43-48) thereof, second portions (67-72) formed in the shape of arcs of a circle, and preferably undulated, which are subdivided into two groups of equal number between the ends of said first portions (61-66), and radial joining portions (73-84) that are provided between the ends of each one of said first portions (61-66) and the adjacent second portions (67-72).

11. Rotor according to claim 10, characterized in that the radial extension of said joining portions (73-84) is smaller than the thickness of the segments of a cylinder (5, 6, 7; 31, 32, 33) as emasured on a plane that is orthogonal to the axis of rotation (X) of the rotor.

12. Rotor according to any of the preceding claims, characterized in that said first elastic means (11, 12, 13; 52, 53, 54) have a length that is smaller than or equal to the one (H) of the core (1; 30).

13. Rotor according to any of the preceding claims, characterized in that said plane elements (8, 9; 34, 35) are in the form of rings made of a non-magnetic material, preferably aluminium, and that the end portions of the wrapper (10; 36) are joined to said plane elements (8, 9; 34, 35) by means of a simple mechanical deformation, without any use of foreign bonding and/or sealing materials.

14. Rotor according to any of the preceding claims, characterized in that it is part of an electronically commutated motor used for driving a hermetic refrigerant compressor.

15. Method for producing a rotor according to any of the preceding claims, comprising substantially the phases of:

- making the core (1; 30) by stacking a plurality of magnetic laminations;

-associating said second elastic means (21-26; 37-42; 60) to respective supporting means (14-19; 43-48) integrally provided on the core;

- obtaining a rotor sub-assembly fonned by the core (1;30), said second elastic means (21-26; 37, 42; 60), and the segments of a cylinder (5; 6, 7; 31, 32, 33) arranged along the outer surface of the core (1; 30);

- inserting the cylindrical wrapper (10; 36) along the axis of rotation (X) around said rotor sub-assembly with a radial play with respect thereto;

- inserting said first elastic means (11, 12, 13; 52, 53, 54) in the respective supporting means provided integrally on the core (1; 30) so as to obtain a circumferential spacing of the segments of a cylinder (5, 6, 7; 31, 32, 33) from each other due to the same first elastic means (11, 12, 13; 52, 53, 54) interfering with the contiguous longitudinal edges of the segments of a cylinder (5, 6, 7; 31, 32, 33);

- inserting said plane elements (8, 9; 34, 35) so as to enable them to come into contact with the end portions of the core (1, 30);

- submitting the end portions of the wrapper (10; 36) and/or the plane elements (8, 9; 34, 35) to a circumferential mechanical deformation so as to enable them to mutually join to form a cylindrical, substantially sealed shell;

- magnetizing the rotor so as to enable the contiguous longitudinal edges of the segments of a cylinder (5, 6, 7; 31, 32, 33) to become opposite magnetic poles.

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International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(71) Applicant *(for all designated States except US)*: ZANUSSI ELETTROMECCANICA S.P.A. [IT/IT]; Via Giardini Cattaneo, 3, I–33170 Pordenone (IT).

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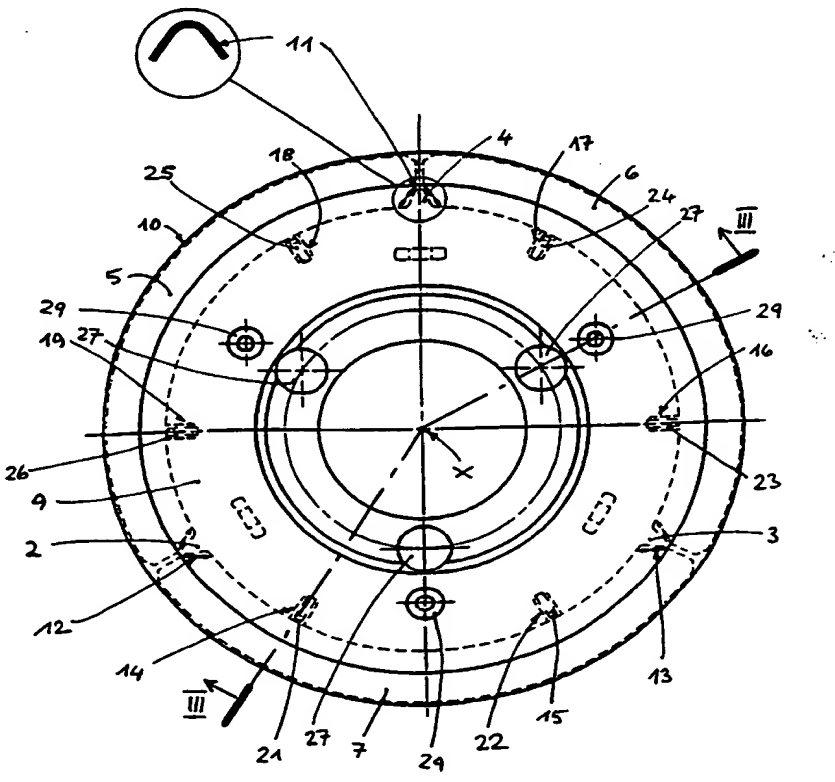
(74) Agents: GIUGNI, Valter et al.; Propria S.r.l., Via Mazzini, 13, I–33170 Pordenone (IT).

(54) Title: ROTOR FOR AN ELECTRONICALLY COMMUTATED MOTOR AND IMPROVED METHOD FOR THE MASS PRODUCTION THEREOF

(57) Abstract

Rotor for an electric motor that comprises a core (1), segments of a cylinder (5, 6, 7) made of magnetizable materials, a substantially cylindrical retaining wrapper (10) whose end portions are joined to at least a pair of plane elements (8, 9). The rotor also comprises first elastic means (11, 12, 13) having a length that is not smaller than the length of the core and being supported by means (2, 3, 4) that are integrally provided in the core parallelly to the axis of rotation (X) of the rotor, which interfere with contiguous longitudinal edges of the segments of a cylinder so as to keep said segments circumferentially spaced from each other. In a preferred manner, the rotor also comprises second elastic means (21–26) which are adapted to make up for the longitudinal and radial plays of the various parts of the rotor so as to ensure that the outer surface of the segments of a cylinder keeps in contact with the inner surface of the wrapper. The invention further relates to a method for producing the rotor. Use: electronically commutated motors, eg. used to drive hermetic refrigerant compressors. Advantages: facilitates mass production, with a high quality–to–cost ratio.



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ROTOR FOR AN ELECTRONICALLY COMMUTATED MOTOR AND IMPROVED METHOD FOR THE MASS PRODUCTION THEREOF

DESCRIPTION

The present invention refers to a rotor for electronically commutated motors.

Electronically commutated motors are becoming increasingly popular in many applications owing to the kind of efficiency and rpm-adjustment easiness that they usually offer.

Brushless-type electronically commutated motors are for instance being used to drive hermetic compressors of household refrigeration appliances, further to industrial equipment applications, in view of reducing the energy usage thereof.

A rotor for electronically commutated motors of this kind, as well as the methods and the equipment to produce it, is the subject of a number of a patent publications. In particular, US-A-5 040 286 and US-A-5 237 737 desclose a substantially closed rotor with a cylindrical core of magnetic steel laminations, a plurality of magnetizable sintered segments in the form of segments of a cylinder that have approximately the same length as said core and are adapted to be adhesive-bonded on to the outer surface thereof, a retaining wrapper obtained from a welded tube of non-magnetic stainless steel, and terminal closing rings made of aluminium.

The above cited retaining wrapper has an inside diameter that is smaller than the outside diameter of the rotor sub-assembly formed by the core and the magnetizable segments, as well as larger than the outside diameter of said terminal closing rings.

The drawbacks connected with these prior-art solutions derive mainly from the large dimensional tolerances of the magnetizable segments, so that the pressure exerted by the retaining wrapper is subject to considerable variations and the adhesive, which among other things needs quite a long time for hardening, must be applied in a particularly careful manner in order to ensure that it duly fills up the gaps or small sockets that are specially provided to that purpose. Furthermore, the ultimate shape of the rotor, as defined by the outer surface of the retaining wrapper, owing to the fact that the latter must at least partially follow the actual shape of the magnetizable segments. only seldom turns out to comply with the theoretical, ie. cylindrical one in practice, which introduces a few balancing problems.

All these drawbacks may quite easily pile up to constitute a considerable problem when the rotors have to be produced to as high output volumes as several thousands pieces per day, such as for instance in the case of motors used to drive the hermetic compressors of household refrigeration appliances. As a matter of fact, under these conditions it proves quite a difficult task to combine high quality and reduced production costs.

In view of doing away with some of these drawbacks, innovative design solutions have been developed by this same Applicant concerning the rotor of an electronically commutated brushless-type motor and disclosed in the Italian utility model applications nos. PN98U000003 filed on January 20, 1998 and PN98U000016 filed on March 10, 1998, whose contents are fully incorporated here.

It is a purpose of the present invention to provide a rotor of an electronically commutated motor, which may even be of a type differing from the brushless one,

which is fit for mass production and, at the same time, optimizes the features that are claimed in the above cited Italian utility model applications.

A further purpose of the present invention is to provide a method enabling such a rotor to be mass produced to high quality standards, at reduced production costs and with the use of relatively simple tools and equipment.

These and further aims are reached when the rotor and the method to produce it have the features and characteristics as recited in the appended claims.

The invention will anyway be more readily understood and appreciated from the description of some preferred embodiments thereof which is given below by way of non-limiting example with reference to the accompanying drawings, in which

- Figure 1 is a simplified exploded view of a first embodiment of the rotor of an electronically commutated motor of the brushless type;

- Figure 2 is a view of the rotor of Figure 1. as seen according to the axis of rotation thereof;

- Figure 3 is a view of the same rotor as seen along the cross-sectional line III-III of Figure 2, wherein some parts are however illustrated in a simplified manner;

- Figure 4 is a same view as the one illustrated in Figure 2, however referred to a second embodiment of the rotor;

- Figure 5 is a three-dimensional view of a magnet retaining spring that may be used in both above mentioned embodiments of the rotor;

- Figure 6 is a longitudinal view of the spring shown in Figure 5;

- Figure 7 is a cross-sectional view of the spring of Figures 5 and 6.

As illustrated in Figure 2 and, albeit in a more simplified manner, also in Figures 1 and 3, in a first preferred embodiment a cylindrical stack of magnetic laminations forms the substantially cylindrical core 1 of a rotor, adapted to be joined with a shaft (not shown) which, in the case that the rotor is part of a brushless motor intended for driving a hermetic refrigerant compressor for refrigeration appliances, is in a generally known manner a common shaft for both the motor and the compressor. Each lamination is punched in such a manner as to ensure that three radial protrusions, for instance in the shape of a V, and six longitudinal notches with a substantially rectangular shape are provided along the periphery thereof, in addition to the usual notches and perforations that are provided to handling and centering purposes. The core 1, which is obtaining by stacking a plurality of laminations, is in this way provided with three longitudinal prismatic ribs 2, 3 and 4, spaced at 60°-angles from each other, as well as cylindrical channels 27. Only the grooves 14, 15 provided between the longitudinal ribs 2, 3 are shown in Figure 1, whereas also the grooves 16, 17 and 18, 19 provided between two other pairs of ribs 3, 4 and 4, 2, respectively, are shown in Figure 2.

The rotor further comprises:

- three segments of a cylinder 5, 6 and 7, which are made of a magnetizable material, preferably a sintering material for permanent magnets, as this is largely known to those skilled in the art. As this is explained to a greater detail farther on in this description, said segments of a cylinder 5, 6 and 7 are adapted to be fixed to the outer surface of the core 1 so as to form a so-called rotor sub-assembly. For this reason, each one of said segments of a cylinder 5, 6 and 7 has an inside diameter that is substantially the same as the diameter of the outer surface of the core 1, in the zones comprised between the longitudinal ribs 2, 3 and 4, and an amplitude that is slightly less than 120°. Furthermore, the longitudinal edges thereof are provided with bevels that are respectively oriented towards the axis of rotation X and the exterior of the rotor (see Figure 2);

- three spring clips 11, 12 and 13, made out of music steel strips, that are called centering springs in this description. As clearly shown in the enlarged-scale detail appearing in Figure 2, which illustrates the spring clip 11 associated to the rib 4, the centering springs 11, 12 and 13 have a V-shaped cross-section corresponding to the shape of the bevels provided along the longitudinal edges of the segments of a cylinder 5, 6 and 7 facing the axis X of the rotor. Anyway, the transverse dimension T of the centering springs 11, 12 and 13 is not smaller than the width of the longitudinal ribs 2, 3 and 4 (regardless of the actual shape of such ribs) along the circumference of the core 1, whereas their length is preferably smaller than or equal to the height H of the core 1 (see Figure 1);

- two end rings 8 and 9 made of a non-magnetic metal, for instance aluminium, that are provided with centering bulges 28 and 29;

- a cylindrical retaining wrapper 10, made of a non-magnetic metal, such as for instance AISI 304 steel, having a length L which is greater than the height H of the core 1 and an inside diameter that is greater than or equal to the outside diameter of the rings 8 and 9;

- a plurality of corrugated spring clips, that are referred to as retaining springs and indicated at 21 through to 26 (see Figure 2) in this description, which are made out of music steel wire. Each one of these springs is adapted to be inserted in one of said longitudinal grooves 14-19 of the core 1. Figure 3 shows for instance the corrugated spring 21 inserted in the groove 14.

In view of producing a rotor as described above, and illustrated in Figures 1 to 3, a preferred method according to the present invention comprises the following phases:

1) realization of the core 1 by stacking a plurality of magnetic laminations so as to obtain the above indicated characteristics;

2) insertion of the retaining springs 21-26 in the longitudinal grooves 14-19 of the core 1;

3) obtainment of a rotor sub-assembly formed by the core 1, the retaining springs 21-26, and the segments of a cylinder 5, 6 and 7 arranged along the outer surface of the core 1. Owing to the action exerted by the retaining springs 21-26 upon the segments of a cylinder 5, 6 and 7, this phase is carried out without any use of adhesives, unlike what on the contrary happens when prior-art production methods are used, and this proves to be particularly advantageous in the case of very large output quantities, since it enables the rotor to be produced at clearly enhanced daily productivity rates;

4) insertion of the cylindrical wrapper 10 along the axis of rotation X around said rotor sub-assembly. Owing to the presence of an intentionally provided radial play, due to an inside diameter having been selected for the wrapper 10 which is greater than or equal to the outside diameter of the rotor sub-assembly, even this phase of the method according to the present invention can be carried out without encountering any particular difficulty, while again contributing to a reduction in manufacturing time requirements. The outer surface of the wrapper 10 is in this way capable of maintaining a cylindrical shape and, as a result, the rotor can be balanced in a much easier manner. In turn, the retaining springs 21-26 make up for the longitudinal and radial plays introduced by the different dimensional tolerances of the various parts. In this way, the outer surface of the segments of a cylinder 5, 6 and 7 is able to stay in contact with the inner surface of the wrapper 10, whereas the inner surface thereof may also be slightly spaced from the outer surface of the core 1. During the operation of the motor, the centrifugal force is in this way directed in the same direction as the one of the action exerted by the retaining springs 21-26, thereby minimizing the risk for the segments of a cylinder 5, 6 and 7 to break down, considering that, being these segments made of sintered metal, they have a relatively low mechanical strength;

5) insertion of the centering springs 11, 12 and 13 along the axis of rotation X (as indicated by the three parallel arrows appearing in Figure 1) starting from an

end side of the wrapper 10, so as to enable them to be supported by the ribs 2, 3 and 4 and, as this has already been described above, so as to enable them to interfere with the bevels facing the axis X of the rotor provided on the contiguous longitudinal edges of the segments of a cylinder 5, 6 and 7. A precise circumferential spacing between the segments of a cylinder 5, 6 and 7 is in this way obtained in the rotor, without any risk for said segments to come into contact with each other, said circumferential spacing playing a quite important role in enabling a high electric efficiency of the motor to be obtained;

6) insertion of the rings 8 and 9 so as to enable them to come into contact with the end portions of the core 1, without interfering with the end portions of the wrapper 10;

7) circumferential deformation of the end portions of the wrapper 10 onto the rings 8 and 9, so as to enable them to be mutually joined by a seam-folding operation that brings about a cylindrical, substantially sealed shell around the core 1 of the rotor (in this connection, it should be pointed out that, for reasons of greater simplicity, the rotor is shown in Figure 3 as it appears before this phase is carried out);

8) magnetization of the rotor so as to enable the contiguous longitudinal edges of the segments of a cylinder 5, 6, 7 to become opposite magnetic poles (see Figure 1).

A second embodiment of the rotor according to the present invention is illustrated in Figure 4.

With respect to the afore described first embodiment, the rotor remains practically unchanged in the following features thereof:

- the three segments of a cylinder, made of a magnetizable material, which are now indicated with the reference numerals 31, 32 and 33:

- the two terminal rings, made of a non-magnetic material, of which only the one now indicated at 34 is shown;

- the cylindrical wrapper, which is also made of a non-magnetic metal material and is now indicated at 36;

- the retaining springs, which are now indicated at 37 through to 42.

As compared with the afore described first embodiment, this second embodiment introduces following variants:

- the core 30, which is still formed by a stack of magnetic laminations, is provided, further to the longitudinal grooves regularly spaced from each other by an angle of 60°, and now indicated at 43 through to 48 in the Figure, for the retaining springs 37-42, with three peripheral slots 49, 50 and 51. Said slots, that have a cross-section in the shape of substantially a Ω and are spaced from each other by an angle of 120°, extend for a relativily short radial length starting from the outer surface of the core 30;

- the three centering springs, which are now indicated at 52, 53 and 54 in the Figure, have a cross-section in the shape of a Ω and are so sized as to be able to be accomodated in the peripheral slots 49, 50 and 51 of the core 30, with the end portions thereof that are bent to a shape of a V so as to be adapted to interfere withthe bevels facing the axis of the rotor that are provided along the contiguous longitudinal edges of the segments of a cylinder 31, 32 and 33. These features are evidenced in the detail illustrated to an enlarged scale in Figure 4, which only shows the slot 49 and the therewith associated centering spring 52 with its bent end portions 55 and 56. For reasons of greater simplicity, no mention is made here of items that are equal to or unchanged with respect to the ones that have already been described in connection with the afore cited first embodiment, as long as they have no direct relevance with the present invention.

The manufacturing method for this second embodiment of the rotor according to the present invention is substantially the same as the one described in connection with the afore cited first embodiment, of which it maintains the basic features and particular advantages. In particular, the insertion of the wrapper 36 around the rotor sub-assembly is facilitated by the fact that the inside diameter of the former is not smaller than the outside diameter of the latter; the longitudinal and radial plays that are introduced by the different dimensional tolerances of the various parts of the rotor are made up for by the retaining springs 37-42, which ensure that the outer surface of the segments of a cylinder 31, 32 and 33 is able to remain in contact with the inner surface of the wrapper 36; the action exerted by the bent, V-shaped ends of the centering springs 52, 53 and 54, owing to the interference thereof, ensures that a precise circumferential spacing is maintained between the segments of a cylinder 31, 32 and 33.

A variant of the above embodiments is illustrated in the Figures 5 to 7, in which the use is advantageously provided of a single retaining spring 60, made of steel music wire and shaped to a configuration of a "cylindric cage", instead of the plurality of the afore described elementary retaining springs. Said retaining spring 60 consists of:

- first parallelly extending portions, indicated at 61 through to 66 in the Figures, provided in an equal number as the corresponding grooves on the periphery of the rotor core (ie. six in this particular example of embodiment) - see Figures 5 and 6;

- second portions in the shape of arcs of a circle, and indicated at 67 through to 72 in the Figures, which are subdivided into two groups of equal number between the ends of said first portions 61-66 (ie. three plus three in this particular example of embodiment) - see Figure 5;

- short radial joining portions, indicated at 73 through to 84 in the Figures, which are provided between the ends of each one of said first portions 61-66 and the adjacent second portions 67-72 (see Figure 7), so that they are of course

provided in a number that is the double of the number thereof (ie. in the number of twelve in this example of embodiment) - see Figure 5.

Further features of the retaining spring 60 are as follows:

- both said first portions 61-66 and said second portions 67-72 are not rectilinear, but undulated, ie. a fact that increases the elastic yielding property thereof in all directions and, therefore, the capability thereof of making up for the different dimensional tolerances of the various parts (see Figures 5 and 6);

- the length thereof (ie. the distance between the two groups of second portions 67-72) is substantially equal to the height H of the rotor core (see Figure 5);

- the radial extension of the joining portions 73-84 is smaller than the thickness of the segments of a cylinder of the rotor sub-assembly, as measured on a plane that is orthogonal to the axis of rotation thereof.

The use of a single retaining spring 60 enables all of the segments of a cylinder to be at the same time and most precisely positioned around the core. When adding this feature to the other afore cited advantages, the possibility emerges of further increasing both the manufacturing productivity and the quality of the rotor.

It will be appreciated that further embodiments and variants of the present invention, in particular as far as such features are concerned as the number as the shape of the segments of a cylinder (or any other type of magnetizable elements of the rotor sub-assembly), the centering springs, the retaining springs, the construction of the core, the method for joining the wrapper and the rings (or any other end elements that may be used), may be developed in any different manner by those skilled in the art without departing from the scope of the present invention.

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10 CLAIMS

1. Rotor for an electronically commutated motor that comprises a core (1; 30) formed by a cylindric stack of magnetic laminations, a plurality of segments of a cylinder (5, 6, 7; 31, 32, 33) made of preferably sintered magnetizable materials, a 15 substantially cylindrical wrapper (10; 36) surrounding said segments of a cylinder (5, 6, 7; 31, 32, 33) when these are positioned on the outer surface of the core (1; 30), at least a pair of plane elements (8, 9; 34, 35) joined to the end portions of said wrapper (10; 36) at the extremities of the core (1; 30), characterized in that it also comprises first elastic means (11, 12, 13; 52, 53, 54) having a length (L) that is not 20 smaller than the length (H) of the core (1; 30), and are supported by means (2, 3, 4; 49, 50, 51) that are integrally provided in the core (1; 30) parallelly to the axis of rotation (X) of the rotor, which interfere with contiguous longitudinal edges of said segments of a cylinder (5, 6, 7; 31, 32, 33) so as to keep said segments circumferentially spaced from each other.

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2. Rotor according to claim 1, characterized in that, on their contiguous longitudinal edges, said segments of a cylinder (5, 6, 7; 31, 32. 33) are provided with bevels that are preferably facing the axis (X) of the rotor.

30 3. Rotor according to claim 1 or 2, characterized in that the means for supporting said first elastic means (11, 12, 13) substantially consist of ribs (2, 3, 4) that are integrally provided, regularly spaced from each other, on the outer surface of the core (1; 30);

4. Rotor according to claim 2, characterized in that said first elastic means (11, 12, 13), and preferably their supporting ribs (2, 3, 4) as well, have a cross-section in the shape of substantially a "V".

5. Rotor according to claim 1, characterized in that the means for supporting said first elastic means (11, 12, 13) substantially consist of peripherally arranged slots (49, 50, 51) that are provided, regularly spaced from each other, on the outer surface of the core (30) and have a cross-section in the shape of a "Ω", said slots being adapted to accomodate the first elastic means (52, 53, 54) which are also in the shape of a "Ω" with their end portions bent to the shape of a "V" interfering with the contiguous longitudinal edges of the segments of a cylinder (31, 32, 33).

6. Rotor according to any of the preceding claims, characterized in that said substantially cylindrical wrapper (10; 36) has an inside diameter that is not smaller than the outside diameter of the rotor sub-assembly formed by the core (1; 30) and the segments of a cylinder (5, 6, 7; 31, 32, 33), and is made of a non-magnetic material, preferably an austenitic steel.

7. Rotor according to claim 6, characterized in that it also comprises second elastic means (21-26; 37-42; 60), supported by means (14-19; 43-48) that are integrally provided in the core (1; 30), which are adapted to make up for the longitudinal and radial plays of the various parts of the rotor so as to ensure that the outer surface of the segments of a cylinder (5, 5, 7; 31, 32, 33) keeps in contact with the inner surface of the wrapper (10; 36).

8. Rotor according to claim 7, characterized in that the supporting means (14-19; 43-48) for said second elastic means (21-26; 37-42; 60) are grooves extending parallelly to the axis of rotation (X) of the rotor and provided in a number that is equal to or a multiple of the number of the supporting means (2, 3, 4; 49, 50, 51) for said first elastic means (11, 12, 13; 52, 53, 54).

9. Rotor according to claim 7 or 8, characterized in that said second elastic means (21-26; 37, 42) are elementary undulated springs.

10. Rotor according to claim 7 or 8, characterized in that said second elastic means (60) comprise a cylindric cage made of metal wire and consisting of first parallel, preferably undulated portions (61-66) provided in a number equal to the supporting means (14-19; 43-48) thereof, second portions (67-72) formed in the shape of arcs of a circle, and preferably undulated, which are subdivided into two groups of equal number between the ends of said first portions (61-66), and radial joining portions (73-84) that are provided between the ends of each one of said first portions (61-66) and the adjacent second portions (67-72).

11. Rotor according to claim 10, characterized in that the radial extension of said joining portions (73-84) is smaller than the thickness of the segments of a cylinder (5, 6, 7; 31, 32, 33) as emasured on a plane that is orthogonal to the axis of rotation (X) of the rotor.

12. Rotor according to any of the preceding claims, characterized in that said first elastic means (11, 12, 13; 52, 53, 54) have a length that is smaller than or equal to the one (H) of the core (1; 30).

13. Rotor according to any of the preceding claims, characterized in that said plane elements (8, 9; 34, 35) are in the form of rings made of a non-magnetic material, preferably aluminium, and that the end portions of the wrapper (10; 36) are joined to said plane elements (8, 9; 34, 35) by means of a simple mechanical deformation, without any use of foreign bonding and/or sealing materials.

14. Rotor according to any of the preceding claims, characterized in that it is part of an electronically commutated motor used for driving a hermetic refrigerant compressor.

15. Method for producing a rotor according to any of the preceding claims, comprising substantially the phases of:

- making the core (1; 30) by stacking a plurality of magnetic laminations;

-associating said second elastic means (21-26; 37-42; 60) to respective supporting means (14-19; 43-48) integrally provided on the core;

- obtaining a rotor sub-assembly formed by the core (1;30), said second elastic means (21-26; 37, 42; 60), and the segments of a cylinder (5, 6, 7; 31, 32, 33) arranged along the outer surface of the core (1; 30);

- inserting the cylindrical wrapper (10; 36) along the axis of rotation (X) around said rotor sub-assembly with a radial play with respect thereto;

- inserting said first elastic means (11, 12, 13; 52, 53, 54) in the respective supporting means provided integrally on the core (1; 30) so as to obtain a circumferential spacing of the segments of a cylinder (5, 6, 7; 31, 32, 33) from each other due to the same first elastic means (11, 12, 13; 52, 53, 54) interfering with the contiguous longitudinal edges of the segments of a cylinder (5, 6, 7; 31, 32, 33);

- inserting said plane elements (8, 9; 34, 35) so as to enable them to come into contact with the end portions of the core (1, 30);

- submitting the end portions of the wrapper (10; 36) and/or the plane elements (8, 9; 34, 35) to a circumferential mechanical deformation so as to enable them to mutually join to form a cylindrical, substantially sealed shell;

- magnetizing the rotor so as to enable the contiguous longitudinal edges of the segments of a cylinder (5, 6, 7; 31, 32, 33) to become opposite magnetic poles.

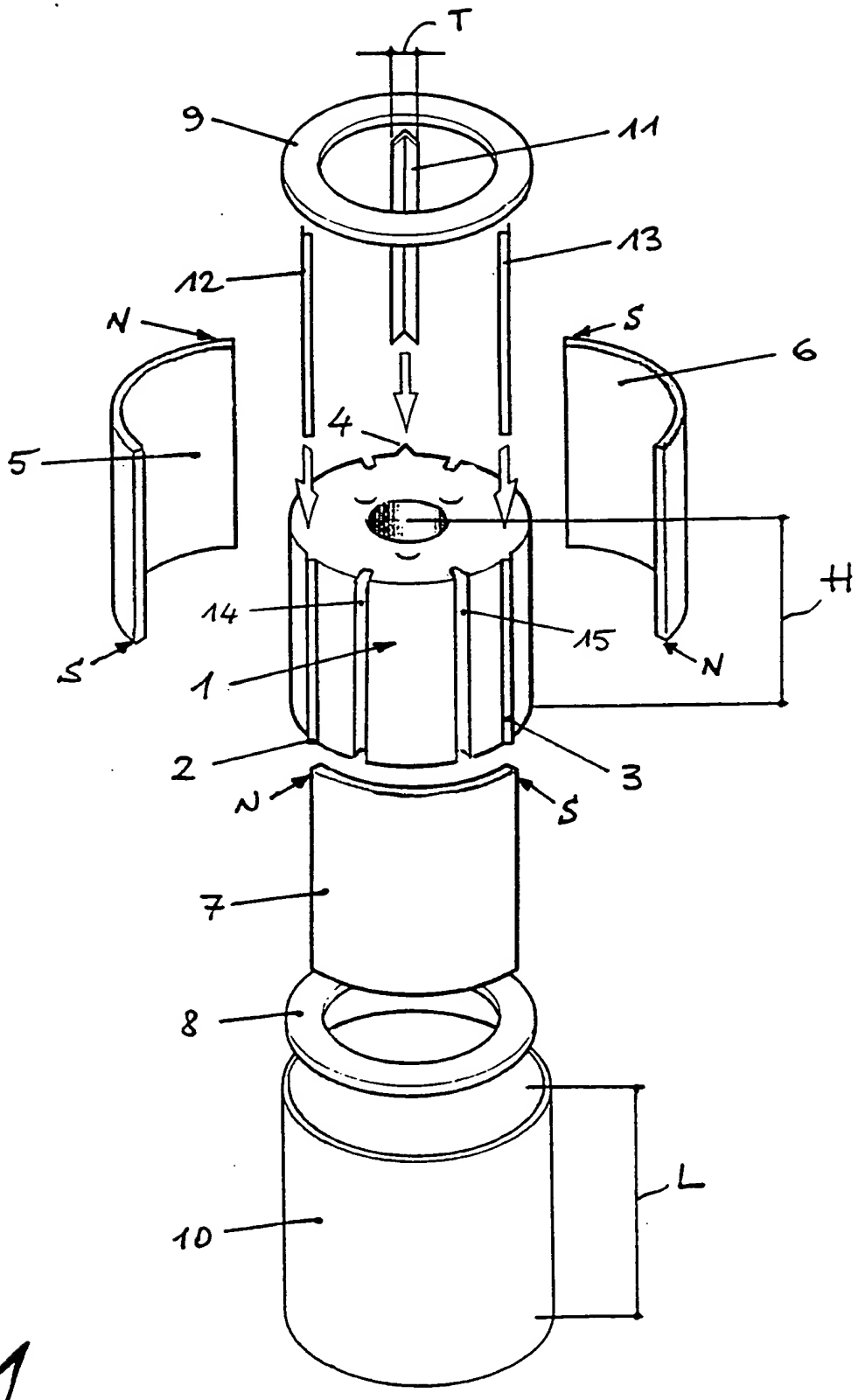

FIG. 1

FIG.2

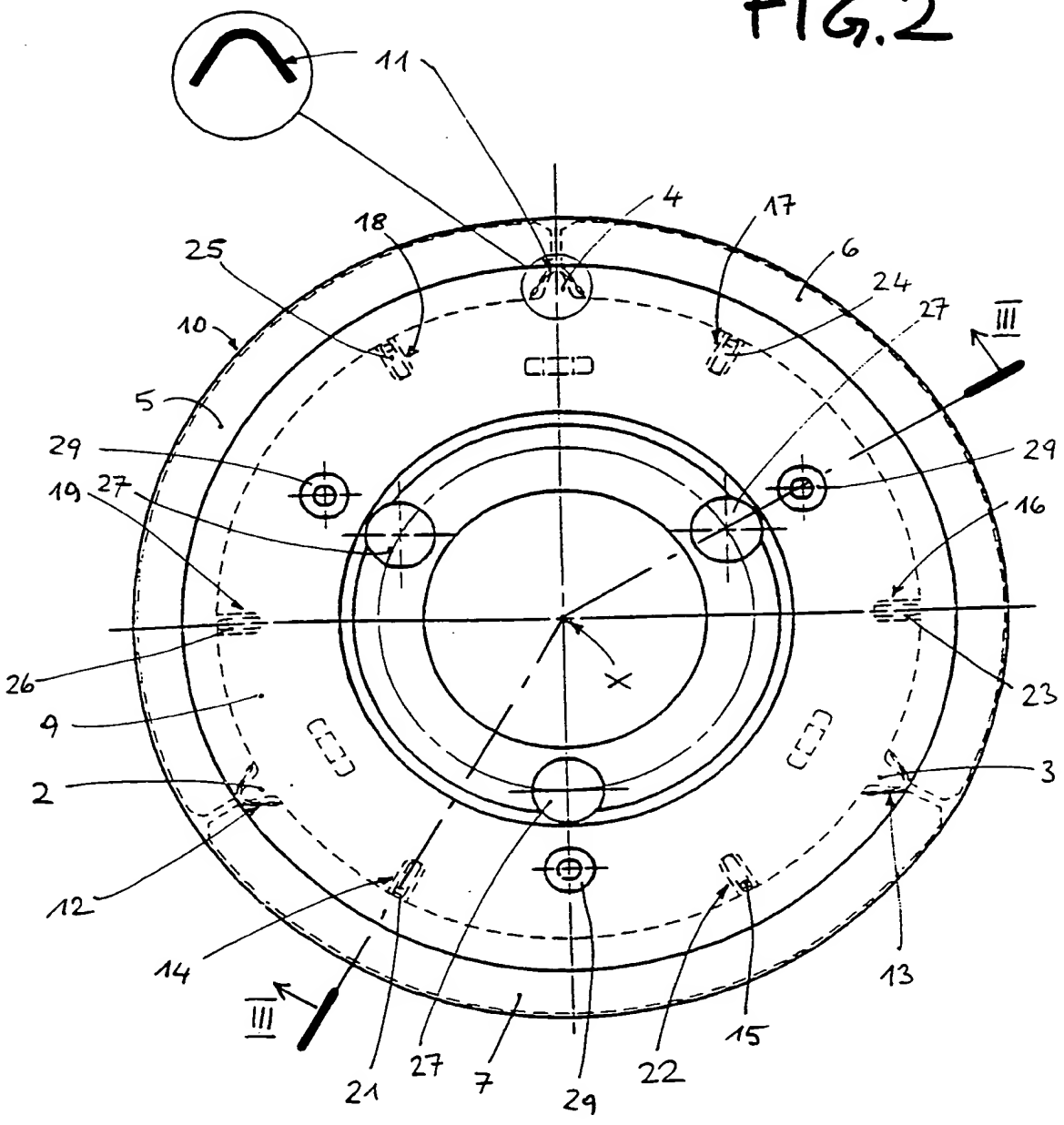
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FIG.3

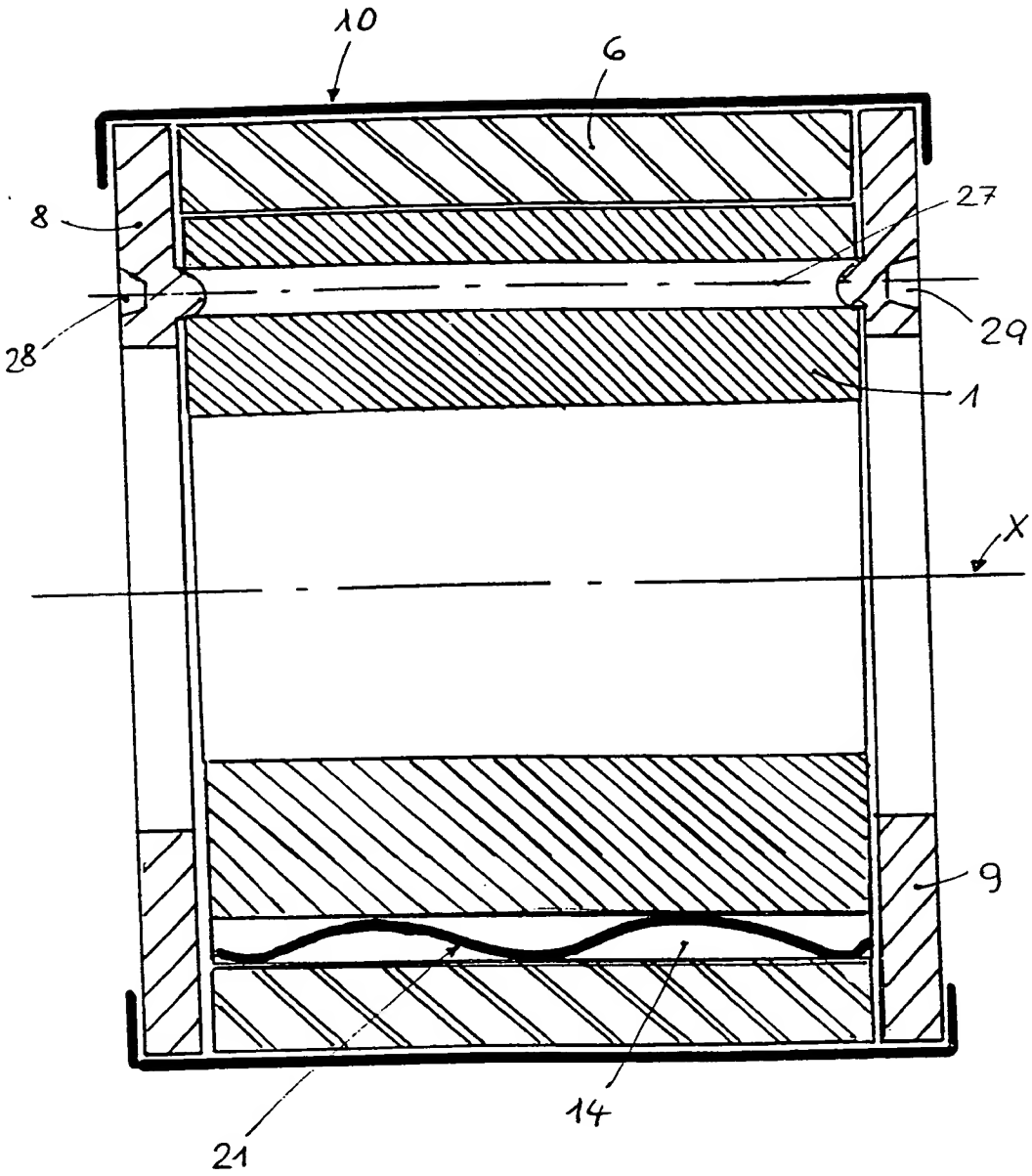
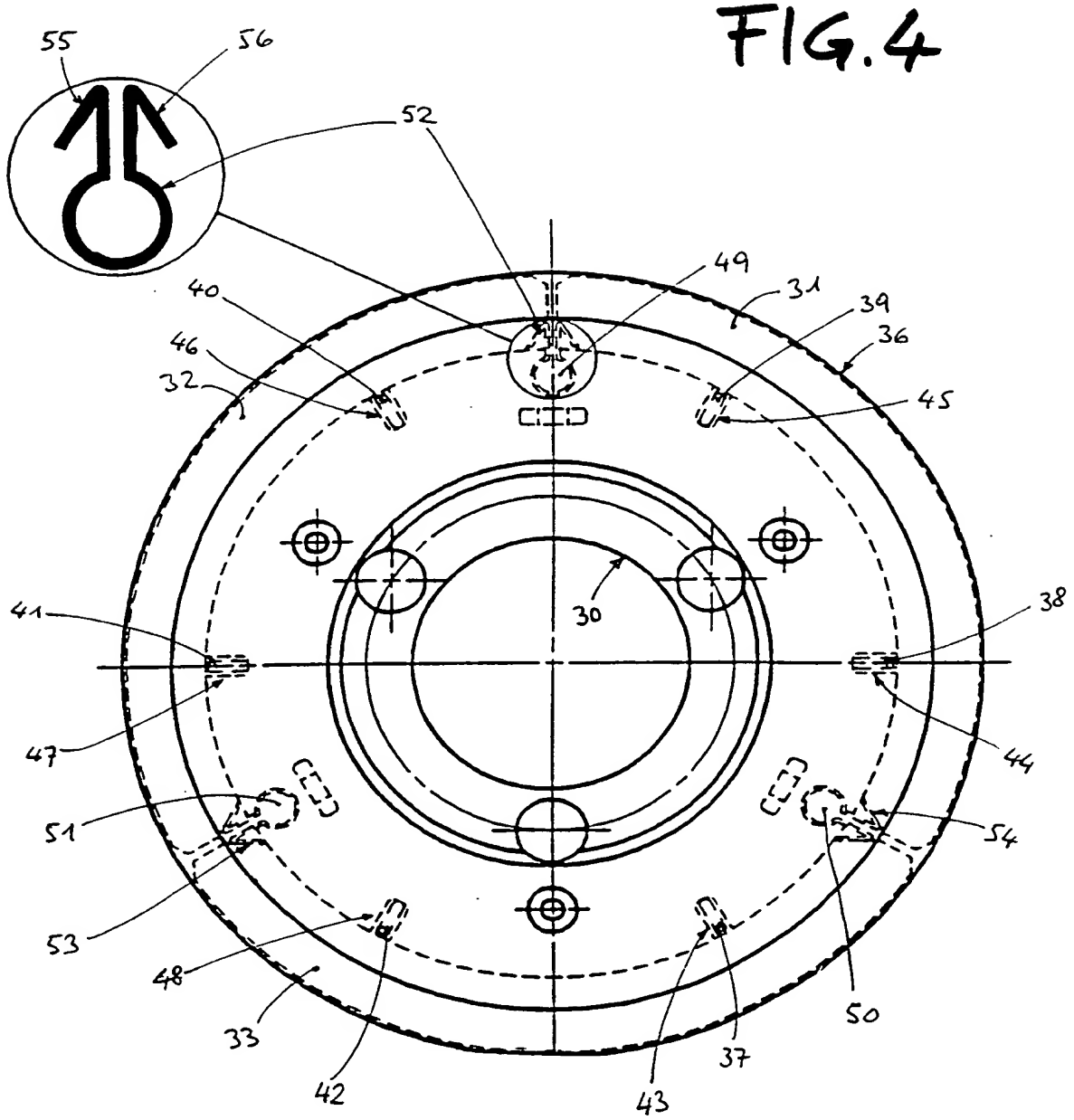


FIG.4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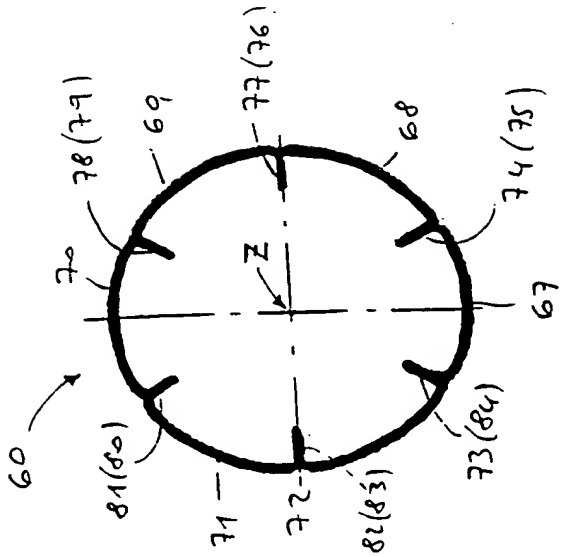

FIG.7

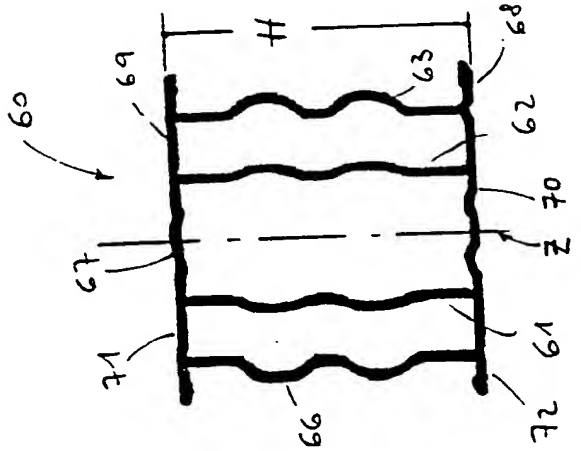

FIG.6

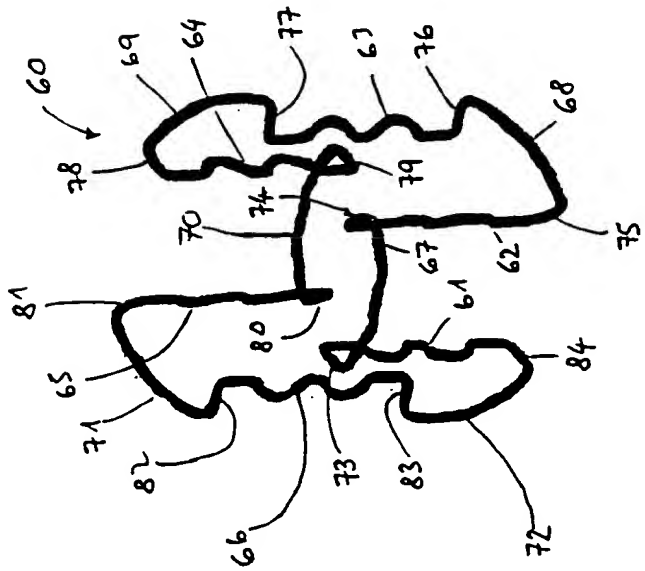

FIG.5

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	FOR FURTHER ACTION	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
ZEM/98/274		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/EP 99/ 00108	11/01/1999	20/01/1998
Applicant		
ZANUSSI ELETTROMECCANICA S.P.A. et al.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

[ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

[ ] contained in the international application in written form.

[ ] filed together with the international application in computer readable form.

[ ] furnished subsequently to this Authority in written form.

[ ] furnished subsequently to this Authority in computer readble form.

[ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

[ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [ ] **Certain claims were found unsearchable** (See Box I).

3. [ ] **Unity of invention is lacking** (see Box II).

4. With regard to the **title,**

[X] the text is approved as submitted by the applicant.

[ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**

[X] the text is approved as submitted by the applicant.

[ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. 2

[X] as suggested by the applicant.

[ ] None of the figures.

[ ] because the applicant failed to suggest a figure.

[ ] because this figure better characterizes the invention.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 99/00108

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H02K1/27 H02K15/03

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H02K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	EP 0 459 355 A (HITACHI LTD) 4 December 1991 see column 6, line 30 - column 7, line 37; claims 1,5; figures 8-15	1-4,6,12 13,14 7,9,15
Y A	US 5 237 737 A (ZIGLER ROBERT V ET AL) 24 August 1993 cited in the application see the whole document	13 2-4,6
Y	PATENT ABSTRACTS OF JAPAN vol. 097, no. 011, 28 November 1997 -& JP 09 182332 A (DAIKIN IND LTD), 11 July 1997 see abstract; figures 1-15	14

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 May 1999	02/06/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Zanichelli, F

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 99/00108

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 581 140 A (FUTAMI TOSHIHIKO ET AL) 3 December 1996 see column 7, line 57 - column 8, line 13; figures 5,6,31	1,2,7, 12,13
A	PATENT ABSTRACTS OF JAPAN vol. 098, no. 003, 27 February 1998 & JP 09 308148 A (MITSUBISHI ELECTRIC CORP), 28 November 1997 see abstract	5
A	US 4 412 145 A (VOSS ERICH ET AL) 25 October 1983 see the whole document	5
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A	PATENT ABSTRACTS OF JAPAN vol. 012, no. 318 (E-650), 29 August 1988 -& JP 63 080744 A (MITSUBISHI ELECTRIC CORP), 11 April 1988 see abstract	7,8
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1

INTERNATIONAL SEARCH REPORT

[redacted]rmation on patent family members

[redacted]nternational Application No
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